Solid State Phenomena 2012 vol.190, pages 413-416

Superconducting probe of electronic correlations and exchange field based on the proximity effect in F/S nanostructures

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Abstract

The proximity effect and competition between the BCS and LOFF states are studied in the Cooper limit for thin F/S and F/S/F nanostructures, where F is a ferromagnet and S is a superconductor. The dependences of the critical temperature Tc on the exchange field I, electron correlations λf, and the thickness df of the F layer are derived for F/S bilayers and F/S/F trilayers. Two new π-phase superconducting states with electron-electron repulsion in the F layers of F/S/F trilayers are predicted. A 2D LOFF state in F/S/F trilayers is possible only in the presence of a weak magnetic field and the appropriate parameters of the F and S layers. The absence of the suppression of 3D superconductivity in short-period Gd/La superlattices is explained and the electron-electron coupling constant in gadolinium is predicted. A method of superconducting probe spectroscopy based on the proximity effect is proposed for determining the symmetry of the order parameter, the magnitude and sign of electron correlations, and the exchange field in various nanomagnets F. © (2012) Trans Tech Publications.

http://dx.doi.org/10.4028/www.scientific.net/SSP.190.413

Keywords

0- and π-phase superconductivity and magnetism, F/s nanostructures, proximity effect, Ferromagnetism, Inhomogeneous superconductivity, Mutual accommodation